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Crippa, F., Marshall, A. H., Merchich, G., & Zenga, M. (2014). Hospitalization in Geriatric Wards: Considerations on the Evaluation of the Outcome. *Procedia Economics and Finance*, 17, 248-255.
[https://doi.org/10.1016/S2212-5671\(14\)00869-7](https://doi.org/10.1016/S2212-5671(14)00869-7)

Published in:
Procedia Economics and Finance

Document Version:
Publisher's PDF, also known as Version of record

Queen's University Belfast - Research Portal:
[Link to publication record in Queen's University Belfast Research Portal](#)

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Innovation and Society 2013 Conference, IES 2013

Hospitalization In Geriatric Wards: Considerations On The Evaluation Of The Outcome

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Abstract

Within a defined law framework, the Italian central health system dictates the standards for hospitalization to local care units, which are in turn allowed to establish their own effectiveness criteria. The appropriateness of the hospitalization decision is therefore predetermined at patients admission, whereas its effectiveness relies on the ex post patient well-being as a result of the complex system of reciprocal relations between patients and healthcare agents at the ward level. We consider the outcomes in geriatric wards referring to the national health system, with respect both to patients traits at the individual level and wards/hospital settings. The risk that models the healthcare outcome is accordingly adjusted for covariates at the different levels of analysis (Goldstein & Spiegelhalter, 1996), thus allowing to differentiate among outcomes in terms of the hospitalization structure and, when appropriate, of territorial aggregation.

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Selection and peer-review under responsibility of the Organizing Committee of IES 2013.

Keywords: Multilevel model; health outcome; table league; risk adjustment.

1. Introduction

In the last decades the proportion of elderly population has increased across all western countries, showing the highest growth rate amongst groups of all ages. As a reflection, elderly patients account for the largest increase in hospital admissions (OECD, 2004). This increase implies an increasingly larger demand of health care services dedicated to people aged more than 65 years, whose health conditions become poorer. As a matter of fact, increases

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in life expectancy at birth, terms of years, do not necessarily imply an unchanged quality of life, due to higher risk of disabilities and illnesses later in life (Fig.1). In particular, it involves an expansion of admissions, therefore leading to an overall increase in patients' length of stay (LOS) in hospital. In fact, geriatric patients are at highest risk of acquired disability, cognitive decline, admission to residential care, either as a complication of an illness or as an unfortunate consequence or a negative reaction to a treatment (Ellis et al., 2011). It is enough to consider how, in Italy in 2012, 37% of the admissions to hospital involved the elderly, absorbing nearly half (49%) of the overall LOS days.

This study moves from the prospect of exploiting official data on length of stay in the 20 Italian regions as a potential source of information for evaluating geriatric wards hospitalization and the relative outcome. To the point, the study focuses on in-hospital mortality rate in order to explore potentials and criticalities of elaboration of official data. As a matter of fact, the assessment of the in-hospital mortality rate, as an outcome of the health system, is provided from administrative informations on LOS in a differential analysis with respect to wards/hospitals as well as to regions. Such a framework is apt to involve variables at each level involved in the process, in terms of the characteristics provided by the aforementioned data. As far as the elderly are concerned, their age, gender, health status and chronic condition or severe pathology are provided. As far as wards are concerned, their ownership, public or accredited private, together with the dimension given by number of beds are known, whilst the availability of regional information is restricted to its total number of wards. On this basis, the application of a widely reckoned model enables us to highlight the potential and, at the same time, to sketch further directions.

This territorial angle of perspective is suggested by the many changes that have taken place in the Italian National Healthcare System, where several tasks have been transferred from the central government to the regional administrations recently, in a sequence of legislative actions launched some decades ago and still not completed (CNR, 2005). At present, regions are remarkably autonomous when it comes to funding and to the organization of services (such as healthcare service) designed in order to better meet the specific needs of their respective populations.

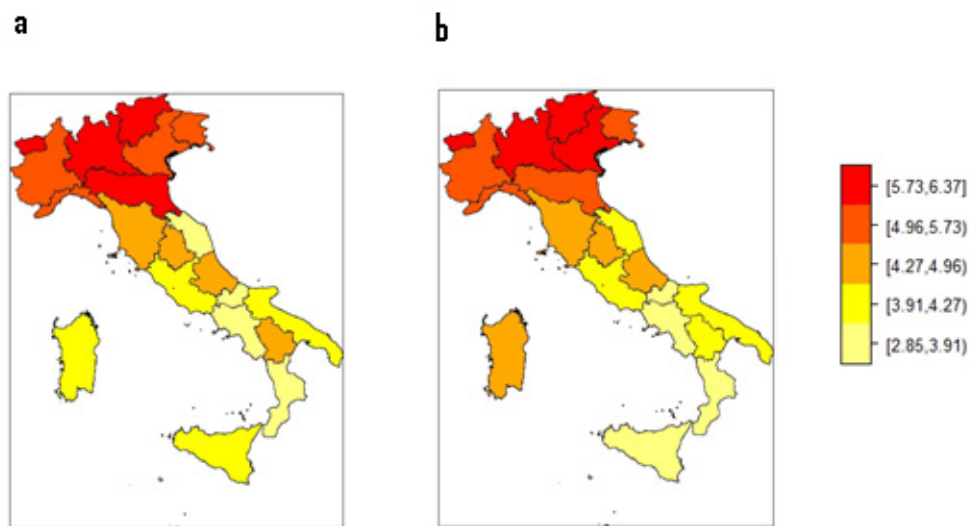


Fig. 1. Life expectancy in good health, for female(a) and male (b) respectively, after age 65 in years, i.e. expected years free from disabilities impairing everyday life activities.

2. Hospitalization outcomes and their assessment: the role of contexts

In the Italian national health system, each local care unit is allowed to establish its own effectiveness criteria, within a clearly defined law frame, while the central health authorities still dictates standards and guidelines for hospitalization. Both the appropriateness of a hospitalization, i.e. the correct assignment of the patient to the proper ward, and its ex post effectiveness, are two dimensions in health care that can be investigated with respect to geriatric wards, either in case they directly belong to the national health system or they are of private ownership and subdued to its accreditation.

Healthcare outcomes are better assessed when the performance at the patients' level is suitably considered as the result of a structure acting at several levels, the patients themselves, the wards/hospitals settings and the regional background. This allows the crude risks to be adjusted for the inner dynamics of the sets of relations between patients and healthcare agents. The option for this modelling raises from the reflection that, in the Italian national health system, Regions have some self-regulation power in health matters and each care unit is allowed to establish its own effectiveness criterion, within a clearly defined law frame, whilst the central health authority dictates the criteria for hospitalization. Thus, final effects on in-patients develop from criteria and decisions originating from the various levels (Fig.2).

This work focuses just on in-hospital mortality rates as measure hospital effectiveness. In-hospital mortality has been proposed in several works (Berta et al.) in the comparative evaluation of quality of care, in terms of the effectiveness on the patients' well-being that each specific hospital has proved in comparison with different healthcare institutions. Mortality rates and other outcomes measures of care have advantages over measures of the process of care, and their dissemination has been reckoned to affect deeply the delivery of health care. 'Mortality outcomes are especially salient. Mortality as an outcome is not difficult to explain to people. Reducing mortality is one of the most cherished goals of all who are involved in health care. Mortality can be reliably measured and it is difficult to misinterpret or to manipulate the result. It is sometimes said, half in jest, that mortality is the <hardest outcome of all> (Schneider, 2002). A fortiori this holds in the case of the elderly.

As a matter of fact, it is widely recognized that many clinical factors, besides the quality of clinical care, affect in-hospital mortality. Various statistical methods have been proposed for the risk adjustment to account for case-mix differences across regions, healthcare providers and patients' so that the performance can be legitimately compared despite differences in factors (DesHarnais et al., 1991; Blumberg, 1986). One of the most straightforward approaches to the comparison of health providers consists in estimating an expected value for each provider' outcome based on the relationship between the outcome itself and its risk factors.

The inclusion in hierarchical models of risk adjustments with respect to covariates was introduced by Goldstein and Spiegelhalter in 1996 and their approach allowed to differentiate among outcomes, with respect to ward and region and adjusting for covariates at the different levels. Results on the state of patient well-being, generated by the delivery of a health service and influenced by covariates expressing the "case mix" combination of the patients' characteristics with those of other agents, can be modelled taking into account the correlation of measurements within the same level. Variables for risk adjustment can be recorded at each level and the variance of the outcome can be partitioned into the different levels.

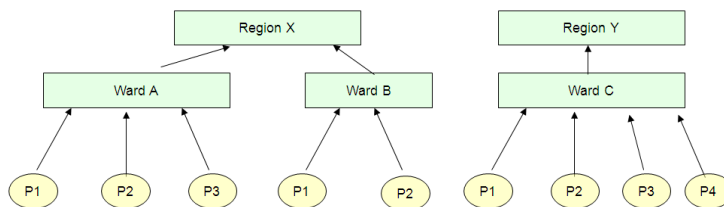


Fig. 2. Hierarchy of hospitalization decisions and patients as final recipients of outcomes at the first unit level

3. Adjusting for actors in the structure of the health care system

Not long ago, the use of multilevel models (also known to as random effects models or hierarchical linear models) was proposed to investigate the relationships between outcomes and variables related to the phenomena (Goldstein, 2005; Hox, 2010; Rice & Leyland, 1996). The option for multilevel modelling stems from the consideration that, in the Italian National Health system, the local and the regional areas of competence are quite clearly distinct, as specified in the previous paragraph. Moreover, due the significant autonomy on the Italian regional healthcare services, the model needs to control for the possible influence of the regional policy on the quality of the geriatric wards. The aim of multilevel models is to control for the presence of a possible intra-wards correlation, which may render patients within the same hospital more alike in terms of experienced outcome than patients coming from different hospitals, everything else held equal.

As aforementioned, in our work the multilevel model includes three level: patient i as level-1 unit ($i = 1, \dots, n$), ward j as level-2 unit ($j = 1, \dots, J$) and region k as level-3 unit ($k = 1, \dots, K$), consistent with typical usage in the multilevel literature (Goldstein, 1995; de Leeuw & Meijer, 2008). The event of interest is death for patient i hospitalized in ward j situated in region k .

Define π_{ijk} as the probability of death, for patient i hospitalized in ward j situated in region k . The logarithm of the odds of this probability is indicated by η_{ijk} :

$$\eta_{ijk} = \log \frac{\pi_{ijk}}{1 - \pi_{ijk}} \quad (1)$$

When covariates are included in the three-level model, π_{ijk} represents the probability of death conditional on the variables x that describe the characteristics of the patient i . Adding random effects to this model, η_{ijk} can be expressed as:

$$\eta_{ijk} = x'_{ijk}\beta + \gamma_{0k} + u_{0jk} + \varepsilon_{ijk} \quad (2)$$

where u_{0jk} is the unobserved hospital random effect among wards, with $u_{0jk} \sim N(0, \sigma_v^2)$; γ_{0k} is the random variation of the intercepts among regions, with $\gamma_{0k} \sim N(0, \sigma_\gamma^2)$. Random components at different levels are assumed uncorrelated and normally distributed, whilst non-null correlations are assumed for patients in the same wards or in the same region. The random effect among wards can be interpreted as the relative effectiveness of hospitals with respect to outcome adjusted for fixed coefficients related to patient, ward and regional characteristics. The models used in this paper were fitted with SAS GLIMMIX (SAS/STAT, 2008).

4. Understanding differential outcomes

Henceforth, death is the outcome under study. It should be considered, at any rate, that two additional outcomes, discharge to another hospital/ward and voluntary discharge can be estimated separately with the same model expressed in (2), based on the same set of information. The distinct outcomes can be used to draw various league tables for rating and ranking.

4.1. Elderly patients in hospital wards: an insight from administrative data

We analyzed administrative hospital admissions data through Hospitalization Discharge Records (in Italian ‘Scheda Ospedaliera di Dimissione, SDO). The data used in this paper consists of the ordinary admissions of 138,188 patients aged 65 years or older to every geriatric ward of the acute care hospitals (197 geriatric wards in total) operating in the 20 Italian Regions throughout 2009. The data was provided by the Italian Health Care Ministry. Individual Hospital Discharge Charts (HDC) are reported in the data set including patient information (gender, age, residence etc.), the treatments received during hospitalization including information such as Disease Related Group (DRG), principal and secondary diagnoses and procedures, data of admission and so on the hospital

(regional code).

Patients aged 85 years or older represent the 39.3% of all patients in the data set, on average the patients age is 82.63 years. Approximately 42% of patients were male. The length of stay of hospitalization is approximately 11 days. Seventeen percent of patients were admitted to the geriatric department from emergency rooms. Approximately 53% of patients were admitted for surgery and 10% for a trauma. The Elixhauser comorbidity index (Elixhauser et al., 1998) shows a comorbidity mean equal to 1.22 with a maximum of 6 and a standard deviation of 1.04. Chronic patients represent approximately 33% of all patients. Moreover 24.3% of the admitted patients had a principal diagnosis of illness at the circulatory system, 22.6% respiratory system problems, 16.4% problems of the Nervous system. The destinations of patients on departure from hospital could include several possibilities: the patient may return home or be transferred to a nursing home, residential home, another ward, or to other hospital. He/she may have died while in hospital. Outcome was coded to describe three locations: home, transfer, or death, the latter only being the object of analysis in this paper. Approximately 80.1% of patients left the geriatric ward to return home, 4% for voluntary discharge; 10.5% died while and the remaining and 9.4% were transferred (Tab.1).

Table 1: Characteristics of elderly patients

Patient level			
N	138.188		
<u>Outcome</u>		<u>Health status</u>	
Death rate	10.50%	Emergency	17.06%
Transfer rate	9.36%	Surgery	53.34%
Voluntary discharge rate	4.04%	Trauma	10.25%
Home discharge rate	76.10%	Chronic Disease	32.98%
		Circulatory Disease	24.28%
<u>Sociodemographic variables</u>		Respiratory Disease	21.56%
Female	57.58%	Nervous Disease	16.35%
Average age (sd)	82.63 (7.16)		
Average los (sd)	11.02 (8.67)	Average Elixhauser index (sd)	1.22 (1.04)

From a supply point of view (Tab.2), the 197 geriatric wards offered structures with on average 24.5 beds and hospitalized on average 701.47 patients during 2009. Regarding the ownership of the hospitals, the 83% were public, the remaining 137% were private for-profit and private not-for-profit. At a regional level, the geriatric wards were on average 9.80 (SD=7.88) with Friuli Venezia Giulia with only 1 geriatric ward and Sicilia with 30 geriatric wards. All of the analysis in this article was done using SAS software version 9.2.

Table 2: Characteristics of the supply

Wards level		
N	197	
Average of patients number (sd)	701.467	(553.655)
Average of beds number (sd)	24.57	(17.50)
Ownership: public	83.08%	
Regions level		
N	20	
Average of wards number (sd)	9.80	(7.88)

4.2. Measuring mortality outcomes: the use of rankings for the improvement of health quality

Wards and regions show a distinctive physiognomy on the risk of death, as random factors estimates (Tab.3), underling the importance of multilevel modelling in developing risk-adjusted measures, in synergy with the role of covariates at the different levels.

Table 3: Estimation of random effects at the level of wards and regions respectively

Random effects	Empty model		Full model	
	Estimate	SE	Estimate	SE
Level 2: Ward	0.258	0.201	0.140	0.023
Level 3: Region	0.842	0.202	0.477	0.071
Intraclass correlation				
ρ Ward	0.059		0.036	
ρ Region	0.192		0.122	
-2ln(L)	88300.73		85544.76	

We considered three sources of variation in the hierarchical logistic model for mortality rate: variation attributable to the patient, the ward and the region. Specifically, we calculated an intraclass correlation coefficient (ICC), which describes the fraction of residual variance (unexplained variation) from the regression on patient characteristics that is accounted for by differences among regions and/or wards. With respect to the logistic models with three levels, we used the method proposed by Li *et al.* (2008). The ward intraclass correlation coefficient referred to the empty model, while significant, was of relatively small magnitude (0.059), but it decreased about by 39% when the covariates were added (full model). Moreover, the highest value of the region intraclass correlation moved from 0.192 to 0.122, thus decreasing by 36% from the empty model to the full model.

Table 4: Estimates of the influence of the covariates on death outcome, at the three levels

Fixed effects	Empty model		Full model	
	Estimate	SE	Estimate	SE
Constant	-2.629	0.085***	-6.813	0.825***
Female			0.231	0.019***
Age			0.043	0.001***
Length of stay			-0.025	0.001***
Emergency			0.479	0.041***
Comorbidity			-0.087	0.010***
Surgery			0.317	0.030***
Trauma			0.121	0.050**
Chronic disease			-0.003	0.047
Circulatory-respiratory disease			0.212	0.020***
Beds number			-0.001	0.003
Public ownership			0.569	0.157***
Level of good health			-0.884	0.291
North Italy			0.016	0.029***

*** p-value<0.0001; ** p-value<0.05; * p-value<0.01

As described in Table 4, mortality was significantly affected by patients' age, gender and type of hospital admission, namely emergency admission. This indicates that older patients, female, admitted via emergency rooms, had higher risk of dying. Multiple comorbidities show a lower risk of dying than patients with fewer reported comorbidities. Patients with a surgical diagnosis or admitted for a trauma are at greater risk of dying than patients diagnosed with a medical condition or admitted without trauma. Moreover, patients leaving early are at the greatest risk of dying than patients leaving later. Circulatory- respiratory disease leads to be at higher risk of dying than other diseases. A chronic disease seems to not affect the risk of dying.

Regarding the ward characteristics, public hospitals showed higher risks of mortality, namely the probability to

die in a public hospital is by 76% greater than in a private one. This outcome is possibly due to the longstanding propensity of public health providers to treat major diseases that have higher mortality rates on their own and that, in addition, are more frequent in aging populations. This owed to some extent to dimensions and structures that tend to favour public investments in medical devices for the cure of very severe pathologies, together with a somewhat higher sustainability of high costs. The number of beds was not significantly associated with the risk of dying. At the regional level, the index of good health seems to not affect positively the risk of mortality. The coefficient for Northern Italy, though significant, was of relatively small magnitude (0.016), implying a death probability in a Northern wards greater by 1% than wards in Southern-Central Italy. Once again, the trend in investment and research experienced by health providers in Northern Italy has possibly privileged the access to more severe pathologies.

Figure 3 shows the rank of the wards respect to the mortality rate, according to the value of u_{0jk} . The 95% confidence intervals identify wards under or over the mean (that is represented by the value 0 onto the ordinates) of risk of mortality. In particular a 95% confidence interval over the mean underlines a ward with a risk of mortality greater than the overall mean. Adjusted for the other covariates, 33 wards show a risk of mortality greater than the overall mean. Positions highest in ranking cannot be trivially classified right away as the 'worst' performance due to health providers just because they register the highest number of death, but suggest the need for further investigation.

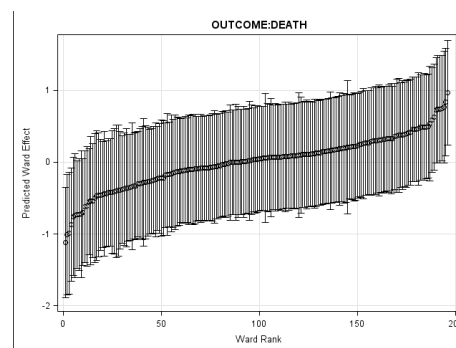


Fig. 3. Thetable league for the death outcome of hospitalization: ranking of wards

4. Conclusive remarks

In the last years, the landscape in assessing quality of health care has changed, assigning it the role of a crucial component of clinical governance. With ongoing concern for patient-centeredness, the need for valid and broadscale measures of quality is evident. However, despite relevant research on the issue, the consensus on what and how to measure in health care is still far to come. In the first place, there is considerable debate regarding whether quality measures should evaluate processes (Rubin et al., 2001) or, instead, outcomes of care, when not both. In the second place, both process indicators and outcomes indicators have their strengths and limitations that need to be thoroughly investigated.

Our contribution shares, as a viewpoint, the evidence that no measure of quality should be used by itself to represent the quality of hospital care, on the contrary overall indices of hospital quality will need to include multiple measures to reflect the complexity of the phenomenon under study and to adopt the best measures for the population considered. In this perspective, we aimed at assessing first a single, fundamental index in the most appropriate methodological way, so as to reach an insight that improves not only the adequacy of its interpretation, but also the choice of other measures of quality. In this perspective, the three levels model allowed us to differentiate among outcomes in terms of the hospitalization structure and, when appropriate, of territorial aggregation.

In these pages we focused on the death outcome only, a crucial but complex measure, as shown by the ranking. In truth, the wards at the highest position in the ranking cannot be trivially and hurriedly classified as the 'worst' wards just because they register the highest number of death, but their results suggest the need for further investigation. We

are pursuing the latter also extending the same methodological approach applied here to other measures of outcome, on the same data, in order to gain a broader perspective in a deeper analytical effort. This will hopefully lead the way to further, in-depth understanding of the characteristics and the needs of different health structures, possibly including some information regarding the wards staff and considering the time series of data.

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